Science and Technology Is Not Simply Equal to Sci-Tech

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The terms "science" (Hanyu Pinyin: *Kēxué*) and "technology" (*Jìshù*), in western languages, are usually used separately with different meanings or together as "science and technology". However, they are often mentioned as "*Kēxué Jìshù*", or even abbreviated as "sci-tech (*Kējì*)" in China (It is used in a similar way in Japan). It not only causes great confusion in conceptual content, but also very misleading in practice. Consciously or unconsciously, it equates technology with science—don't you know that even many politicians and scholars regard science as "productivity" (We should know that science itself is not equal to productivity which must be obtained through technology as well as a complex and serial process to make it a reality), and the ordinaries worship it as the God of Wealth?

In fact, science and technology are clearly distinguishable in both intension and extension. Science in general is the knowledge system with nature as its studying object (plus society and even individuals), which is acquired through experimenting, reasoning, perfecting, *etc.* It also includes the process and institution of scientific activities. However, technology is the totality and working process of all methods, programs, norms, materials, *etc.*, created by the operators who attempt to control the objective environment and to meet the needs of living and production by using knowledge, especially the knowledge of science. Etymologically, the word "science" emerged in the 14th century and originated from the Latin word *scientia* that means knowledge. On the other hand, the word "technology" is the compound of two Greek words—*techne* (skill, craft) and *logos* (logic, word, speech), used for describing artifacts and techniques in making them, and was formally adapted in 1859. Later, although the concepts of the two words changed to some extent, their basic meanings have been preserved. Therefore, science remains in the domain of metaphysics such as "Learning (*Xué*)" and "Way (*Dào*)", while technology belongs to its opposing domain such as "Skill (*Shù*)" or "Vessel (*Qì*)".

Historically, referring to both human civilization and evolution, science (refers primarily to natural science in this article) and technology have developed almost independently—the total time of their marriage or interaction is too short to be taken into account. Technology first appeared during the lengthy evolution process from apes to humans, such as tool making and fire igniting. On the contrary, the real emergence of science only began from the Copernicus-Newton Revolution during the 16th and 17th centuries. Even if one traces back to the ancient Greece, its history is less than 3,000 years. For a long time, technology has always been accompanied by craftsmen's practice, while science has primarily been an "exclusive rights" of aristocratic philosophers or people who were employed by plutocrats from the ancient time to the Middle Age and even to the early period of modern science. Looked back to the beginning of modern age, technology had been developed alone without help from pure science. The invention of steam engine that triggered the Industrial Revolution was indeed resulted from the common sense and practical experience of craftsmen and engineers, benefiting little from mechanics and thermology. It was not until the 1800s that technology had progressed to rely on science. The rising of dye-synthesis industry in Germany in the 1850s was the first example of combining science, technology, and industry.

After the World War II, the relationship between science and technology has become closer and closer: science desires the support of technology, while technology needs science as its stepping-stone, especially between the so-called "big science" and "high technology". As a result, science sometimes is tinted with politics, military, or commerce, and the transformation from science to technology is becoming more and more direct and instantaneous. Particularly in the fields of information technology and genetic engineering, the frontier of science and technology has already been so murky in some projects that there comes the so-called "cognitive-technical complex". Nevertheless, science and technology are generally not the same and should not be blended together.

So what on earth is the difference between science and technology? It is hard to make a complete list,

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but the main points may be summarized as follows. First, science studies nature itself, whereas technology deals with self-made or imaginary artificial objects. Second, science focuses on the part of nature that can be explored and recognized in order to seek the truth and acquire knowledge; technology focuses on the part of nature that can be utilized and manipulated to emphasize its application and benefits for the people. Third, science is curiosity-driven and stays away from the social relations in reality, whereas technology is mission-driven and stands closely to the social relations. Fourth, the objectives of scientific discovery are usually not obvious and need persistent interrogations with much occasionality, whereas the goal of technical inventions is often very clear beforehand, with less occasionality. Fifth, science addresses the questions of "what" and "why", whereas technology has to answer "what to do" and "how to do". Sixth, science mainly employs methodology such as experimentation, reasoning, induction, and deduction, while examination, design, experimentation, and modification are frequently used in technology. Seventh, the final results of scientific research are certain theories or knowledge systems, whereas the fruits of technical activities are processes and artificial objects. Eighth, the evaluating standard on science is either right or wrong based on the truth, whereas utilitarianism is a measure for technology, estimated by advantages and disadvantages or gain and loss. Ninth, science, to some extent, is in value-neutrality, or it only has few elements of value. In contrast, technology possesses value everywhere and all the time. There is an unbreakable bond between technology and value. Tenth, according to R. K. Merton, the norms of science are universalism, communism, disinterestedness, and organized scepticism. However, the norms of technology are quite different, which aim at gaining economic profits and materialized interests, starting with confidentiality agreement and ending with patented inventions.

What should be emphasized is that the essence of science is for freedom: science is a weapon for us humans to battle for freedom and to guide us marching toward new freedom and leaving behind the past, survival and obscuration. The freedom, both internally and externally, is prerequisite for the development of science; scientific research requires the spirit of free exploration. The basic concepts and principles of science are the fruits of the free creations of thoughts and free inventions of sense. The free exchange and publication should be available for scientific achievements. Compared with science, the freedom of technology is highly limited. It does not only mean that the development and utilization of technology is restricted by many factors of the objective reality. What is more important is that, although technology may help people get rid of the restriction of environmental factors and be free to a certain extent, at the same time, people have to adapt the technology passively, which may result in the domination and rule of technology over human nature and the alienation of certain individuals.

From the nature of science it is easy to see that science, especially scientific thoughts, methods, and spirits at its bottom, is interlinked or complementary with humanism that pursues the truth, kindness, and beauty. Humanism without scientific spirits is not a true one but incomplete and deficient. I do not agree to the view that "science is a double-edged sword", nor do I agree that there is "negative knowledge" or "ruin-causing knowledge" in true scientific knowledge. Therefore, I strongly oppose the action that intentionally placing humanism and scientific spirits into the opposite positions while doing anti-science activities with the excuse of carrying forward the humanism. Undoubtedly, it is clear that technology actually is such a sword due to its role of bearing the burden of utility and value. The careful, prudent, and proper use of technology may benefit the people, while the faulty, extreme, and evil use of technology is sure to cause serious damage. Nevertheless, science is Prometheus, but technology may well be Prometheus the Angle, or Mephistopheles the Devil. My personal opinion is that science should have no forbidden zones and technology should be controlled.

By saying that science should have no forbidden zones, I mean that we SHOULD NOT and also CANNOT define boundaries and set forbidden zones for scientific research. The reason for SHOULD NOT is that science is activities of research with nonstop exploration, whose discrete object and purpose usually is indistinguishable. Meanwhile, the fields or questions of science are interrelated and have common grounds so that knowing one is quite helpful knowing the other. Thus, defining boundaries intentionally has little help but constraints to the free development of science; it is destructive to the fundamental and long-term interests and happiness of mankind, and might even jeopardize the survival of human species. (It can well be imagined once the fate of dinosaur is mentioned.) The reason for CANNOT lies on the difficulty that who can define the boundaries and how

to do them. Since humans do not possess the view of God's eyes that can see through everything, defining boundaries and setting forbidden zones is easy to run into counter directions from the original desire. To say that technology should be controlled, I mean that value assessment should be done in a comprehensive way throughout the entire process of technical activities: evil or substandard technology should be firmly restrained or prohibited by all means; the beneficial technology whose advantages highly exceed its disadvantages ought to be utilized and applied properly by promoting the benefit and reducing the harm as much as possible. The technology that cannot be defined immediately can be slowed down, laid aside for some time to see its consequences, or tested in a small scale, until proper decisions can be made after a careful thought. Of course, there will be many conflicts of interest and operational difficulties, but the logic should be clear and the actions should be more or less practical.

The value burden and the dual characters of good and evil in technology raise a greater obligation to the technologists in their social responsibility and moral conscience: they must put the interest, benefit, and happiness of mankind in the very first place and never offer their intelligence and souls on the altar of the Devil. Because modern technology mainly comes from science, scientists should also take indirect responsibilities for the results of technology. They should have consciousness toward the possibility of faulty, extreme, or evil use of scientific knowledge all the time, let the public know the truth, and warn the society in time. They should not release arbitrarily the half-finished products outside laboratories and scientific communities, which may have destructive consequences, before these products are mature, fully understood. The power, scale, scope, input, and output of modern technology are unprecedented, and the people who have the real final say are not the technologists and scientists but the decision-making and reigning hierarchies, who therefore should take major or even full responsibilities for the result of technology.

In order to ensure that science and technology always bring benefit rather than damage to the mankind, three inevitable paths must be simultaneously taken into consideration—the system, the public conception, and humane concerns. First, research activities in social sciences and corresponding social technology should be intensified to conduct and improve the processes of consultation, hearing, decision-making, administration, supervision, and legislation, dealing with the problems of science and technology as they arise; such activities should be effective in normalizing and restricting the behavior of the governing body and its individual party to make sure that the operation keeps on its expected course as much as possible. Second, the people's conception of development, economy, consumption, and even their view of nature and life should be renewed to make them live in harmony with nature, society and each other, leading people who are enjoying their material-rich lives into a perpetual pursuit for the promotion of spirit instead of immersing in the insatiable desire for material wealth and luxurious sensory stimulation. Third, promoting and enhancing the spiritual civilization corresponding with the material civilization by means of humanities, ethics, religions, and social consensus, and gradually eliminating the evil components of humanity while extending the good components through personal life experience and self-examination, therefore promoting people's spiritual state and helping people dealing with themselves, others and nature in a considerate manner.

I am not a despaired pessimist, nor a blind optimist. Instead, I am trying to be a freethinker who keeps the essential tension between the sober realism and the noble idealism. I am confident that with the help of kindheartedness, humanity, and the wisdom of science, obscurity will not persist for long, humans definitely will have a brighter future as long as we do NOT simplistically follow the ancient Chinese philosopher Zhuangtzu's mechanistic principle, "Every machine is made for its purpose that must be in the maker's mind".

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